MAVILOR
INFRANOR GROUP COMPANY
EXPRESS

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JULY 2005

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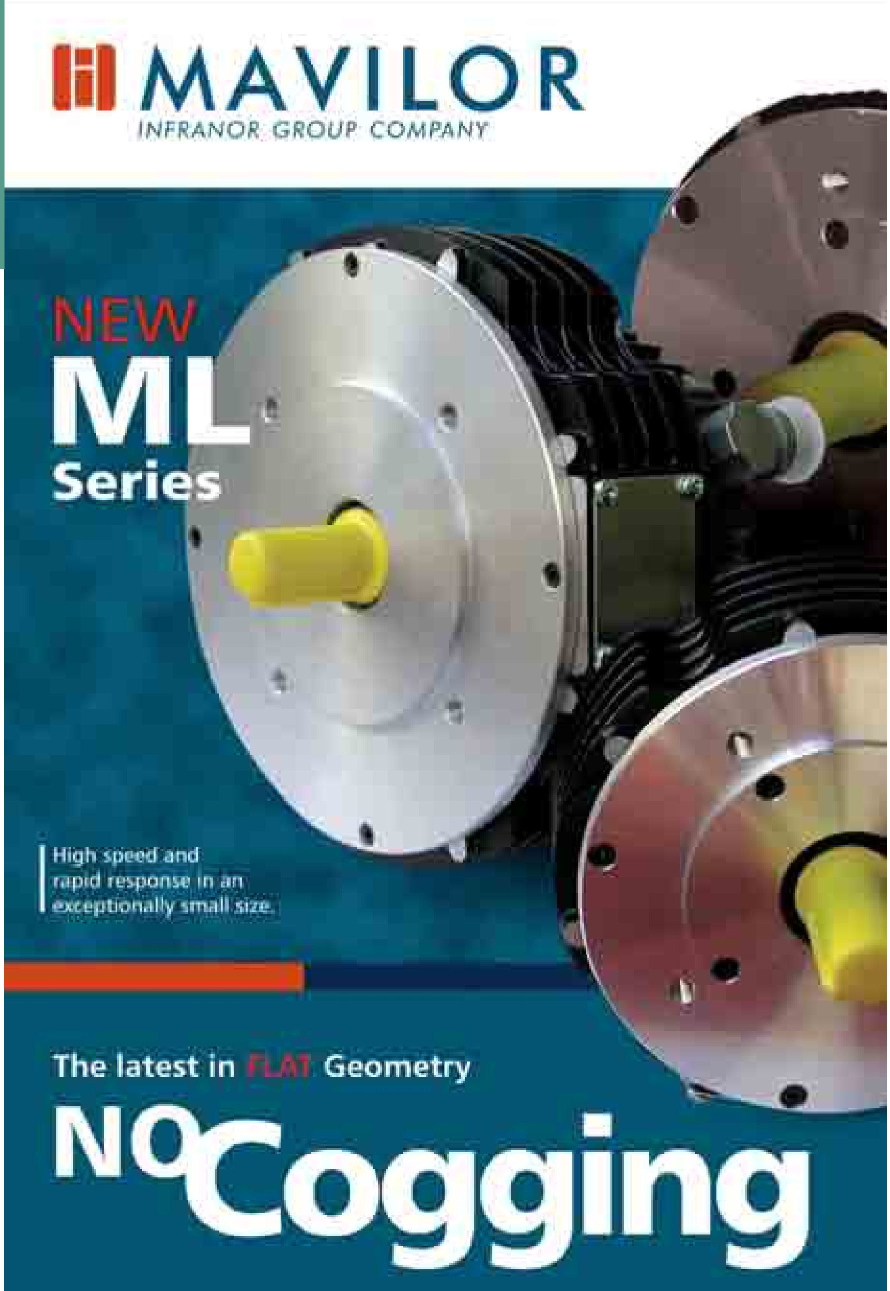
AXIAL MAGNETIC FLUX
HIGH SPEED
FAST RESPONSE IN A SMALL SIZE



INTRODUCTION

In this edition of Mavilor Express we will be taking a look at a research project in wave energy extraction that is currently being done by researchers at Oregon State University. This research is being carried out with the help of a Mavilor brushless AC servo motor.

In the following article we offer readers the news from the recent trade fair that Mavilor had the pleasure of participating in this April in Brazil. Representing Mavilor at Feria Electronic Americas 2005 in Sao Paulo were Francesc Cruellas, Enric Ciurana, and Miguel Angel Rodriguez. The trade fair provided a great opportunity for Mavilor to make important contacts with companies in Brazil and 30 other nations mainly in the Americas.

Lastly, Enric Solsona has contributed an article which explains the start/stop process of a typical servomotor application. He demonstrates how the use of a Mavilor servomotor can achieve a significant increase in production rate.

Thank you, the Mavilor team.

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Ocean Energy Permanent-Magnet, Rack and Pinion Generator Buoy

Researchers at Oregon State University (OSU) have identified significant opportunities and benefits from wave energy extraction. The combination of key OSU facilities, ongoing successful wave energy research, and the tremendous wave potentials off the Oregon coast has led Drs. Annette von Jouanne and Alan Wallace to propose hosting a U.S. Ocean Energy Research and Demonstration Center.

OSU is the prime location to conduct ocean energy research, noting the following strategic facilities:

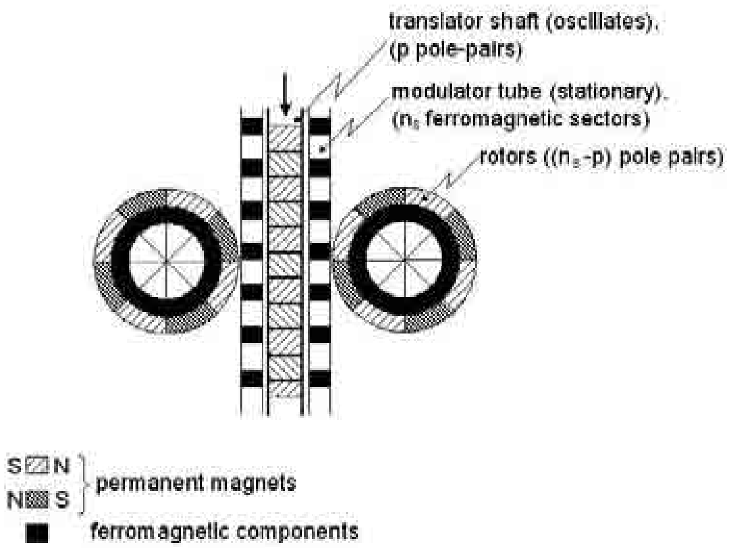
Motor Systems Resource Facility (MSRF)

O.H. Hinsdale Wave Research Laboratory (WRL)

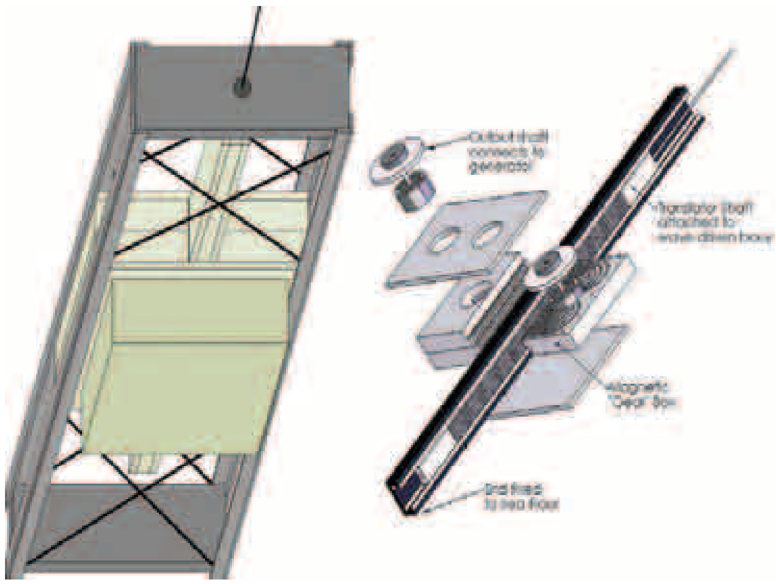
- OSU is the home of the nation's highest power university-based energy systems laboratory, with a 750kVA dedicated power supply and full capabilities to regenerate back onto the grid.
- OSU is the home of the O. H. Hinsdale Wave Research Lab (WRL) with world-class wave tank facilities including a 342 ft. wave flume.

A Mavilor brushless AC servo motor provided by Infranor Inc. is contributing to the testing of a permanent-magnet, rack and pinion gearbox (PMRPG) system designed to allow generators to respond directly to the movement of the ocean, with coupling by magnetic fields for contact-less mechanical energy transmission. While conventional electric generators are rotary, the motion of a buoy in the ocean is linear and oscillatory (i.e. up and down). In the mechanical world, conversion from linear to rotary motion (or vice versa) can be achieved by a rack and pinion (e.g. the steering system of a car): this requires physical contact of the teeth of the pinion with those of the rack. In contrast, for this buoy, contact-less transmission and linear to rotary conversion is being developed as an extension of a concept of permanent magnet gears. In this device the rotary speed of the pinion is greater than the linear speed of the rack making the output more effective for rotary generators (see figures below). This gearing-up technique is obtained by a process of magnetic field modulation.

Concept for Permanent Magnet Rack and Pinion Generator



Permanent Magnet Rack and Pinion Buoy driven Generator (designed and now under construction in MSRF)



FERIA ELECTRONIC AMERICAS 2005

SAO PAULO (BRAZIL) from the 25th to the 29th of April,2005

Mavilor has participated with ICEX (INSTITUTE OF SPANISH COMMERCE) in this Trade Fair, forming part of the Spanish pavillion.

The FIEE 2005, the 23rd International Electrical Energy and Automation Industry Trade Fair has taken place at an opportune moment for the Brazilian electro-electronic industry. In 2004, the electro-electronic industry reached a historic growth ratio, with a 28% increase over the previous year. This factor contributed an increase of 10% in the number of exhibitors who participated in this year´s trade fair.

Exhibitors from 30 countries were brought together for FIEE 2005, which demonstrates the potential for growth in Brazil in this market. Last year it achieved a turnover of R$80 (US 29) billion, which was an increase of 11% from 2003.

Considering that this industrial sector is present in almost all production activities in Brazil, we expect that the business started and developed during this year´s trade fair will exceed even the success of last year´s event. Organizers of the fair have again managed to create a great setting for exchanging experiences and doing big business.

Regarding the motion control sector, Brazil is a huge growing market looking for new opportunities. Now, companies are looking for new products to enlarge and improve their business activity and this is proven by the changes that are happening in this sector during recent years.

Mavilor Motors, S.A. came to the FIEE trade fair looking for new distributors and to create a network of after sales service providers in order to improve the service given to the present customers that already exist in Brasil.

The commercial structure that Mavilor Motors S.A. wants to create in Brazil consists of:

- Having three distributors, one for the Sao Paulo

State, another for Minas Gerais State and the third one for the southern region, which will be Paraná, Santa Catarina or Rio Grando do Sul States.

- Create a network of authorized independent after sales providers, who once having received the necessary training in our products, will be able to support our customers in Brazil.

Another of Mavilor's targets for this trade fair was to attract new customers to enlarge our business in this huge country.

We could say that Mavilor Motors, S.A. has had a successful trade fair, the presence of Mavilor Motors, S.A. has been very positive, in the sense that a lot of good contacts have been made, and people showed a lot of interest for our servomotors.

Now we do not have time to lose. It is time to work hard to be as present as possible in the Brazilian market.

TYPICAL SERVOMOTOR APPLICATION

by Enric Solsona

This article offers an indepth explanation of the advantages of servomotors for high dynamic duty cycle as beverage labels.

START ➝ STOP ➝ PROCESS

START requires an acceleration from 0 rpm until a speed (S) regime is achieved.
STOP requires a deceleration from the nominal speed to 0 rpm.
PROCESS can be for example:

- filling and packing
- cut-to-length
- plastic bag production
- insertion
- pick & place

CYCLE TIME =TRANSFER TIME + PROCESS TIME

From the servo system it is not possible to reduce the process time. However it is possible to reduce the transfer time for the applications where the cycle time is a premium.

The Transfer Time Reduction is possible if:

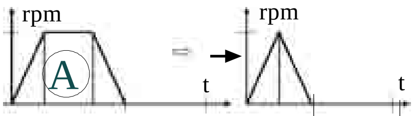
- acceleration time is shorter
- running speed is higher
- deceleration time is shorter
- all the above occurs.

To achieve short acceleration and deceleration times it is necessary to consider the transmission mechanism. In ideal conditions, the inertia of the motor, this is the difficulty to change from one determined speed to another one, must match the inertia of the load.

Note: as inertia of the motor we must consider the rotor and other elements mounted on the motor's shaft such brake or feedback device, although for quick estimations only the rotor's inertia is considered.

In order to highlight the dynamic response of the motor, we will herein consider that the motors are applied in ideal inertia conditions.

The typical pattern of the speed-time curve in a cut-to-length application is:



(fig.1) (fig.2)

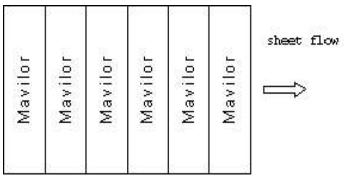
Fig. 2 describes in advance the case described below:

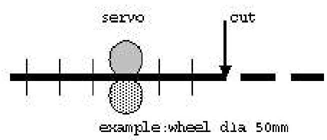
The area A equals to space, distance. This can be achieved following both patterns, although in high demanding dynamic response applications (fig.2) is the most commonly used.

When we apply this to a specific case, like cut-to-length of labels for beverages, we come to some interesting conclusions.

Example:

The Marketing Department at a beverage company requires labels are in the range of 35mm, and the sheets containing the labels to be cut to length, look like in the following sketch:





In these conditions, 1 revolution of the wheel driven by the servomotor equals
L = 157,08 mm.

DATA: Requested production output: 50.000 bottles / h.

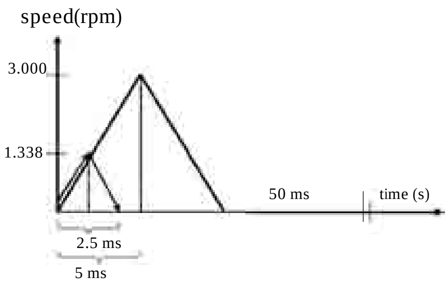
Paper length run per hour: 50.000 * 0,035 m = 1.750 meters / hour à approx. 0,5 m/s.

Cycle time: 0,035 / 0,5 = 70 miliseconds.

Out of this cycle time, we will consider 60 miliseconds for the cutting operation, and the remaining 10 miliseconds are for accelerating and decelerating before stopping for a new cut. In order to ensure 5 miliseconds for the acceleration, the time constant of the motor must be of around 2 miliseconds, and therefore, the maximum theoretical acceleration 157.000 rad/s2.

Let's take a usual AC brushless servomotor around 750W or 1.000W. In reality can be smaller of 200W or as big as 2,0 kW, same applies when comparing the MAVILOR servomotors to others.

It is frequent that the MAVILOR competitors' motors have time constants in the range of 10 ms, for what the approximate time required to achieve 100% value of a set speed is at least 15 miliseconds.



Would the label be shorter, instead of 35 mm as per the above example, the limitations due to poor dynamic response motors are still more evident.

For labels 35mm high, a linear speed of 0,5 m/s requires a total transfer time of 10 ms, which is not achievable unless the servomotor's time constant value is close to 2ms.

D = label length
Speed 2.675 r.p.m.= 280 rad/s.

D = (speed * time) / 2 = [280 rad/s * 0,01 s * 157,08 mm/ 2*pi rad] /2 = 35 mm.

RECAPITULATION

-The application requires a transfer time of 10ms for 35mm labels
-A servomotor of 10ms response time would not achieve more than 1.338 r.p.m. and the distance run in 10ms would be 8,75 mm < 35 mm. Not suitable, in this case.

FACTORS AFFECTING THE TIME CONSTANT VALUE

The mechanical time constant is calculated following

$$\text{Mechanical time constant} = \frac{\text{Inertia} * R}{\text{Kt*EMF constant}}$$

Where: R is the winding resistance in ohm, and Kt is the torque constant.

Motors with a design such that they deliver the same output torque as other motors but with a smaller frame size, will offer an inertia lower than bigger frame size motors and a lower time constant. Equally, motors with a higher resistance value will result in a higher time constant.

Motors with a higher resistance value, increase the losses due to voltage drop, for what the effective voltage is lower than for less resistive motors, and therefore the EMF constant values must be kept low in order to achieve speed values of 3.000 r.p.m. or higher.

This has a negative effect again on the mechanical time constant.

SOME CONCLUSIONS

The resulting cycle time as transfer time + process time varies depending on the transfer time, because the process time is fix.
Necessary cycle time = 10 ms + 60 ms = 70 ms.
Production rate: 3.600 seconds / 0,07 seconds = 51.428 bottles/h > 50.000 (correct)
Production rate with a poor dynamic performance motor of 20ms + 60 ms = 80 ms.600 seconds / 0,08 seconds = 45.000 bottles/h < 50.000 (not correct)

A MAVILOR servomotor would help achieving the production rate, with an additional 14% output compared with the longer response time motor.

In our example, the potential Customer is confronted to the following situation:

-He has bought the motor according to what he found available in the catalogue: 100W, 200W, 400W, 750W, 1,0kW brushless servomotors

-The above powers are related to a rated speed of 3.000 r.p.m. However the motor reaches 1.338 r.p.m., which means that with a similar rated torque the real output power is 50%. These kind of applications are high dynamic response oriented.

The MAVILOR servomotors 220V AC up to a rated power of 3,0kW at 3.000 r.p.m. have time constant values of less than 2,5 miliseconds.

The acceleration required to reach 3.000rpm in 10ms, for instance, is 31.400 rad/s2, and for 2ms like the mentioned MAVILOR servomotors, in excess of 150.000 rad/s2.

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